INTERACTION OF GENES

MODIFICATION OF DIHYBRID RATIO

EXTENSION O MENDELIAN GENETICS

Mendel performed monohybrid and dihybrid crosses taking sweet pea as experimental plant

In monohybrid cross only one trait and its two alternative forms were taken under consideration at a time . Two phenotypes (Red and White flower colour) were obtained . There were only three possible genotype (RR,Rr & rr) with Phenotypic Ratio 3:1 and Genotypic Ratio 1:2:1. RR(Homozygous) and Rr (Heterozygous) are phenotypically alike and both are governed by dominant allele (R). In Dihybrid cross two traits at a time were considered

(Height of plant and colour of flower) . Four phenotypes i.e. tall red(TR), Tall white(Tr), dwarf red(tR) and dwarf white (tr) were obtained by dihybrid cross.

Phenotypic Ratio 9:3:3:1 was obtained

Genotypic Ratio 1:2:2:4:1:2:1:2:1 was obtained

Combinations 1,6,11 & 16 are only homozygous

DIHYBRID CROSS AND ITS ABBREVIATED RATIO

Parents **TTRR** **ttrr**

Parental Gametes **TR** **tr**

F_1 Zygote **Tt Rr** **tall plants Red flowers**

F1 → Gametes ↓	TR	Tr	tR	Tr
TR	TR TR 1	Tr TR 2	tR TR 3	tr TR 4
Tr	TR Tr 5	Tr Tr 6	tR Tr 7	tr Tr 8
tR	TR tR 9	Tr tR 10	tR tR 11	tr tR 12
tr	TR tr 13	Tr tr 14	tR tr 15	tr tr 16

F2 Generation 16 Possible Combinations

(P) TR (Tall Red) : 1,2,3,4, 5,7, 9,10,13 = 9
(R) Tr (Tall White) : 6,8.14 = 3
(R) tR (Dwarf Red) ; 11,12.15 =3
(P) tr (Dwarf White) : 16 =1

By seeing Mendel’s di hybrid Ratio, it becomes clear that different characters are inherited independently . Because of that four combinations are produced in F_2 generation

Mendel concluded on the basis of results of monohybrid and di hybrid crosses performed on sweet pea that

a) One trait (character) is controlled by a gene (factor) existing in two alternative forms (alleles) . The alleles are responsible for two alternative allelomorphs.

b) That different traits assorted independently (segregation of two genes is independent of each other)

After Mendel’s rediscovery by Hugo Devries, Carl Correns and EV Tschermak, many geneticists repeated the same pattern of work using other organisms and different phenotypes but the results were not always according to Mendel’s laws of inheritance, fit with the principles as law of dominance and law of independent assortment.

It became apparent that it is not necessary that a single character (trait) is controlled by one gene only and it is also not true that a gene has only two alleles, may have many alleles and the phenotype may be result of interaction of two genes and their alleles or a character may be controlled by more than one gene and its alleles.

In such a condition 2 or more genes may interact, the resulting phenotype may be result of interaction.

Suppose Gene A is responsible for phenotype A (Red) and Gene B is responsible for phenotype B (white) ,when both A and B are present together may give rise to a new phenotype C (Pink) , but these genes still obey Independent Assortment pattern.

If A and b are two genes, both dominant over their respective recessive alleles a & b ,then interaction will depend on presence of both dominant alleles A & B, Absence of A or B or absence of Both A & B.

Mendel was fortunate to get 3:1 and 9:3:3:1 ratio uniformly because

a) The traits he considered were governed by only one pair of alleles of a gene.

b) The genes and their alleles for different characters were located on different homologous pairs of chromosomes or even if on the same homologous pair the genes for different trait were present at a distance sufficient for cross over

INTERACTION OF GENES

Deviation of Di-hybrid Ratio

Genes usually function or express themselves singly or individually. But, many cases are known where two genes of the same allelic pair or genes of two or more different allelic pairs influence one another. This is called gene interaction

Non-allelic gene Interactions These are interactions between genes located on the same chromosome or on different but non-homologous chromosomes controlling a single phenotype to produce a different expression. Each interaction is typical in itself and ratios obtained are different from those of the Mendelian dihybrid ratios. Some of these interactions of genes are explained here which fall under this category and deviate from Mendel's ratios.

The interaction of genes may be of following types

1) Two gene pairs affecting same character – 9:3:3:1
2) Epistasis, one gene hides effect of other
   a) Recessive Epistasis - 9:3:4
   b) Dominant epistasis - 12:3:1
3) Complementary genes - 9:7 (2 genes responsible for production of a particular phenotype)
4) Duplicate genes – 15:1 (same effect given by either of two genes)
5) Polymeric gene action - 9:6:1
6) Inhibitory gene action - 13 : 3

Gene Interaction	Inheritance Pattern &Example	A-/B- 9/16	A-/bb 3/16	aa/B- 3/16	aabb 1/16	RATIO
Additive gene effect	Comb shape Chicken	9 Walnut	3 Rose	3 Pea	1 Single	9:3:3:1 W:R:P:S
Recessive Epistasis	Coat Colour Mouse	9 Agouti	3 Albino	3 Black	1 Albino	9:3:4 Ag:Bl:Al
Dominant Epistasis	Fruit colour squash	9 white	3 white	3 yellow	1 green	12:3:1 W:Y:G
Complement ary genes	Flower Colour Lathyrus	9 Purple	3 White	3 White	1 white	9:7 P:W
Duplicate genes	Fruit Shape capsella	9 	3 	3 	1 	15:1 Tri: Top
Polymeric Gene action	Fruit Shape Squash	9 Disc	3 Circular	3 circular	1 Long	9:6:1 D:C:L
Inhibitory gene action	Maize Aleurone colour	9 White	3 Red	3 white	1 White	13:3 W:R

ADDITIVE GENE EFFECT

Two gene pairs affecting the same character :

comb shape in chicken

(9:3:3:1-for single character)

Gene R- rose comb -Rp

Gene P –Pea Comb-rP

The dominant alleles of each of the two genes produce separate forms of phenotype when they are alone (heterozygous)

Both R and P when brought together form a new phenotype walnut

Allele R dominant over r

Allele P dominant over p

rr and pp produce single comb

GENETIC EXPRESSION

Parents RRpp x rrPP

(Rose) (Pea)

P. gametes Rp rP

F1 RrPp walnut

F1 gametes

F / M	RP	Rp	rP	rp
RP	RP RP 1	Rp RP 2	rP RP 3	rp RP 4
Rp	RP Rp 5	Rp Rp 6	rP Rp 7	rp Rp 8
rP	RP rP 9	Rp rP 10	rP rP 11	rp rP 12
rp	RP rp 13	Rp rp 14	rP rp 15	rp rp 16

F2 Generation

9:3:3:1

RP-Walnut 1,2,3,4.5,7,9,10,13= 9

Rp –Rose 6,8,14=3

rP- pea 11,12,15=3

rp- Single 16=1

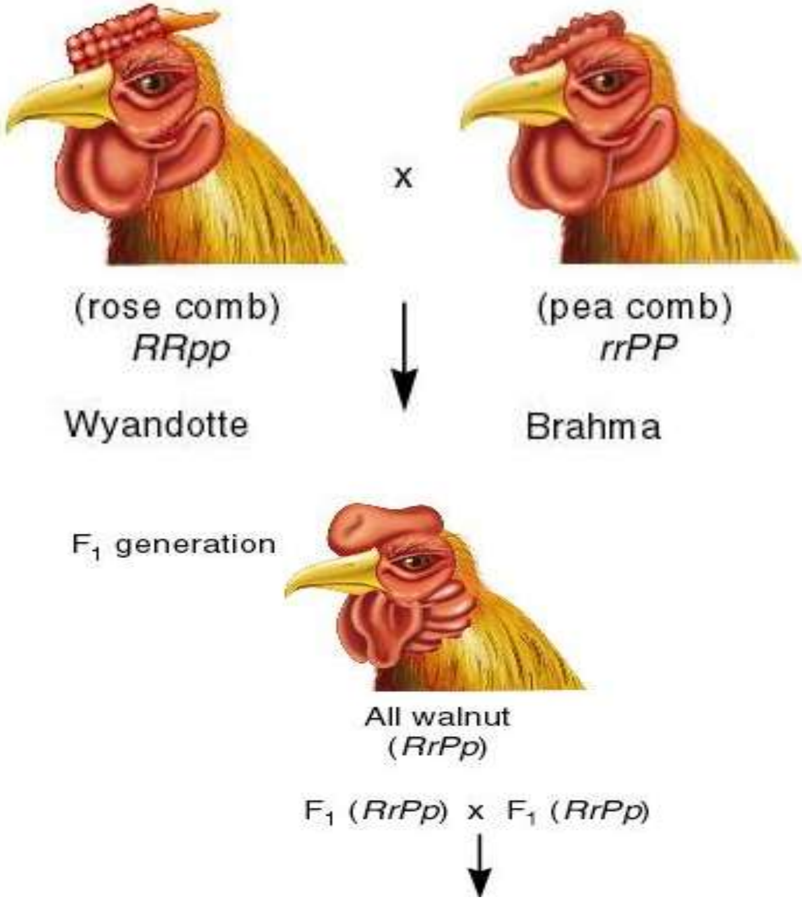
so the ratio is 9:3:3:1 just like normal dihybid ratio for two traits but it is for single trait i.e. comb shape having 4 different forms

A Cross Involving a Two-Gene Interaction : 9:3:3:1 ratio for single trait

RRpp **rrPP** **RrPp** **rrpp**

Four different comb morphologies

Inheritance of comb morphology in chicken described by William Bateson and Reginald Punnett in 1906 : First example of gene interaction



F2 Generation

	RP	Rp	rP	rp
RP	*RRPP* Walnut	*RRPp* Walnut	*RrPP* Walnut	*RrPp* Walnut
Rp	*RRPp* Walnut	*RRpp* Rose	*RrPp* Walnut	*Rrpp* Rose
rP	*RrPP* Walnut	*RrPp* Walnut	*rrPP* Pea	*rrPp* Pea
rp	*RrPp* Walnut	*Rrpp* Rose	*rrPp* Pea	*rrpp* Single

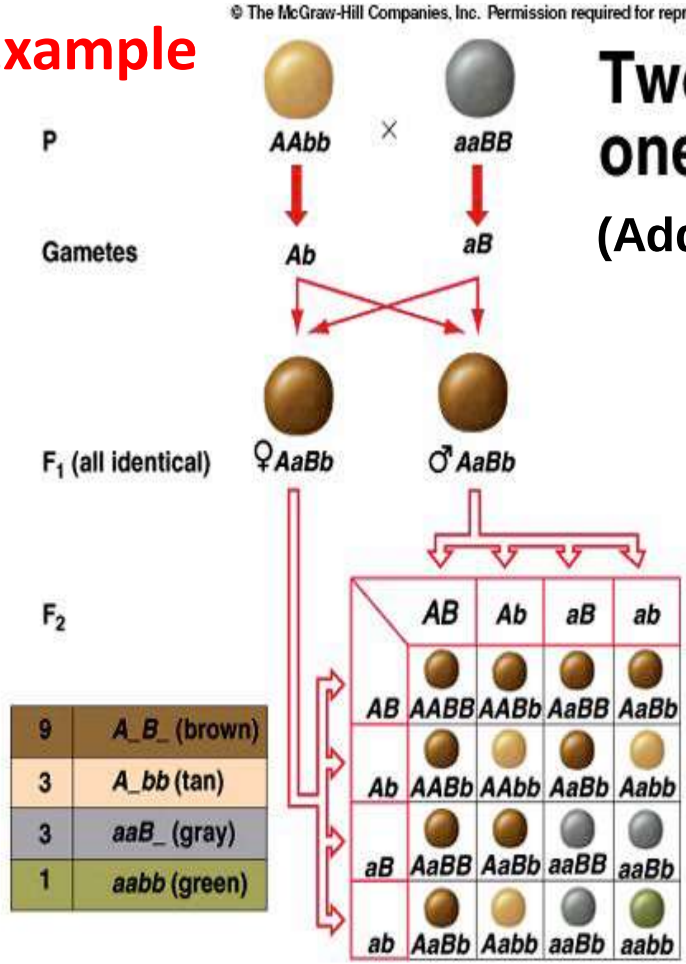
F_2 generation consisted of chickens with four types of combs

9 walnut : 3 rose : 3 pea : 1 single

Bateson and Punnett reasoned that comb morphology is determined by two different genes

2nd Example

Lentil Seed colour



Two genes, one phenotype

(Additive Gene Action)

Where both A and B are present add colour so new phenotype brown is produced

F2

phenotype classes

- **Dominance Relationships:**
  - Tan is dominant to green
  - Gray is dominant to green
  - Brown is dominant to gray, green and tan.
  - Tan and Gray are incompletely dominant, giving rise to brown.
- **Genotypic classes:**
  - Brown: A_B_
  - Tan: A_bb
  - Gray: aaB_
  - Green: aabb

9:3:3:1

There are 4 phenotypes in F2,so are governed by more than one gene
If it was governed by one gene and its two alleles F2 would have shown only 3 phenotypes in 1:2:1 ratio

EPISTASIS

One gene hides the effect of other gene. It is different from Mendel's Dominance which is meant for intragenic alleles (alleles of a gene) but here dominance works at intergenic level (alleles of different genes). One gene masks the expression of another non-allelic gene.

A gene which masks (hides) the action of another gene (non allelic) is termed as epistatic gene. The gene whose effects are masked is called hypostatic gene

For example if two gene A and C with their alleles a and c take part in a cross then epistasis can be of following types

1) Recessive Epistasis -Recessive allele (c) of one gene may hide the effect of dominant allele (A) of other gene

2) Dominant Epistasis Dominant allele (A) of one gene may hide the effect of dominant allele (C) of other gene.

a) Recessive epistasis:

Here the recessive allele masks the effect of dominant allele of other gene.

In mice the wild body colour is known as **agouti**(greyish) and is controlled by a gene A which is hypostatic to recessive allele c.

The dominant allele C in the presence of 'a' gives coloured mice.

In the presence of dominant allele C, A gives rise to agouti.

So, CCaa will be **coloured** and ccAA will be **albino**.

When coloured mice (CCaa) are crossed with albino (ccAA), agouti mice (CcAa) appear in F_1.

cc masks the effect of AA and is therefore epistatic. Consequently,

cc AA is **albino.**

The ratio 9 : 3 : 3 : 1 is modified to **9 : 3 : 4**.

The combination ccaa is also albino due to the absence of both the dominant alleles.

Recessive Epistasis

Example : Coat colour of Mouse

Coat colour is controlled by Gene A ,
Allele A is hypostatic to recessive allele (c)
The dominant allele C in absence of A gives coloured mice
When both C and A are present colour is Agouti (wild type most common) due to banded hair : Near skin Grey yellow Black
Two other colours are Albino and solid black

AACC (agouti) x aacc (albino)

AaCc (all agouti)

AaCc x AaCc

Genotype	Phenotype	
A-C-	Agouti	9/16
A-cc	Albino	3/16
aaC	Black	3/16
aacc	Albino	1/16

The c locus is epistatic to the A locus.
9 (Agouti) :3 (Black) :4 (Albino)
F_2 ratio

Parents **CCaa** **X** **ccAA**

Black **Albino**

Genetic Expression

p. gametes **Ca** **cA**

F1 **CcAa** **-----------------------------------Agouti**

F1 Gametes→

↓

	CA	Ca	cA	ca
CA	CA CA 1 Agouti	Ca CA 2 Agouti	cA CA 3 Agouti	ca CA 4 agouti
Ca	CA Ca 5 Agouti	Ca Ca 6 Coloured	cA Ca 7 Agouti	ca Ca 8 coloured
cA	CA cA 9 Agouti	Ca cA 10 Agouti	cA cA 11 Albino	ca cA 12 albino
ca	CA Ca 13 Agouti	Ca Ca 14 Coloured	cA Ca 15 albino	Ca Ca 16 Albino

← **F2 Generation**

CA –Agouti- 1,2,3,4,5,7,9,10,13=9

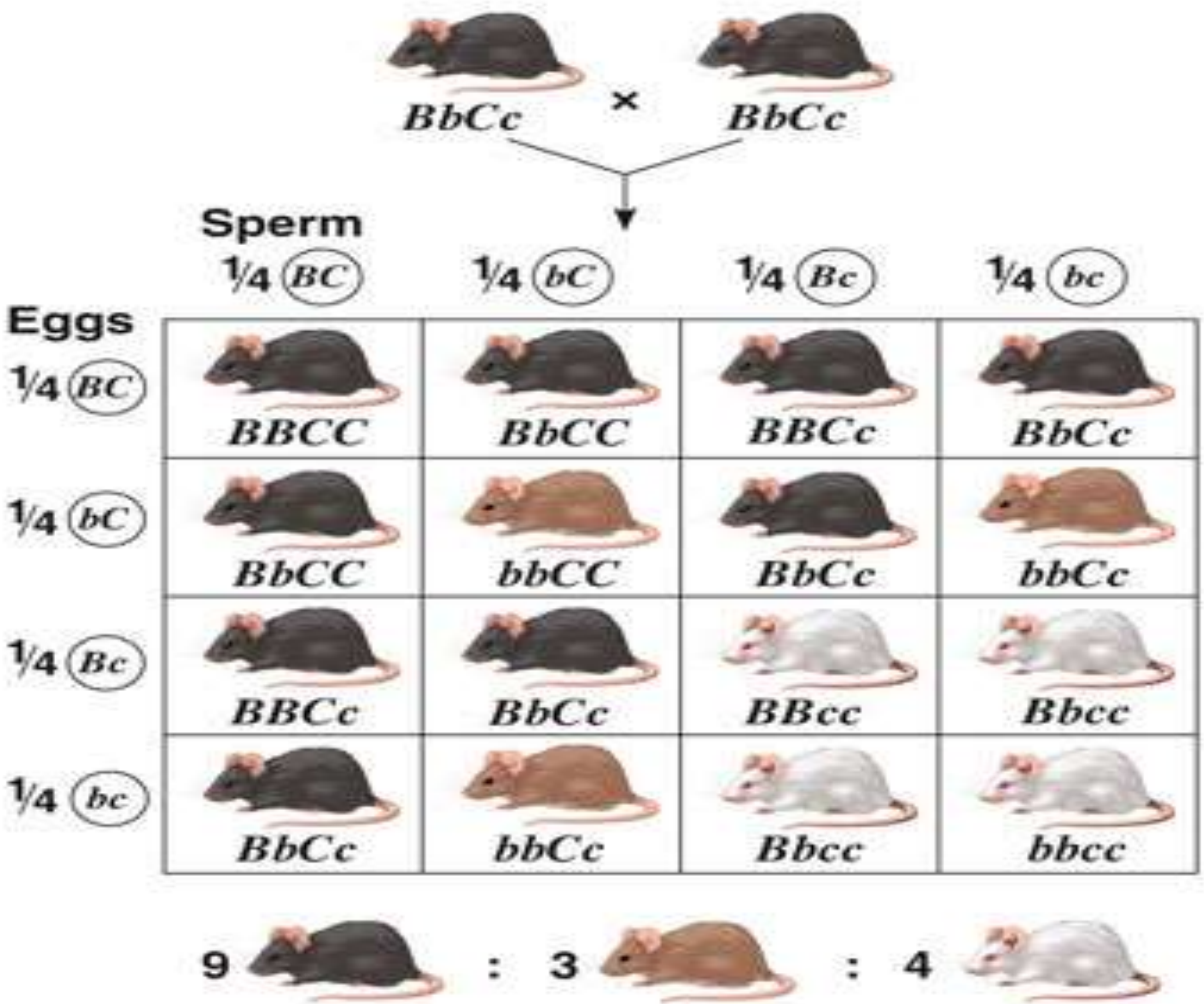
cA- Albino- 11,12,15=3 (c masks the effect of A)

Ca- Black- 6,8,14=3

ca- albino -16=1

So the ratio is 9:3:4 (Agouti:Black:Albino)

Cross between Black and Albino : Genetic Expression



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Parents CCaa Coloured × ccAA Albino

Gamete (Ca) (cA)

F_1 CcAa → Agouti

Selfing of F_1

F_2 Generation

Gametes	CA	Ca	cA	ca
CA	CCAA Agouti	CCAa Agouti	CcAA Agouti	CcAa Agouti
Ca	CCAa Agouti	CCaa Coloured	CcAa Agouti	Ccaa Coloured
cA	CcAA Agouti	CcAa Agouti	ccAA Albino	ccAa Albino
ca	CcAa Agouti	Ccaa Coloured	ccAa Albino	ccaa Albino

F_2 Phenotypic ratio : 9 (agouti) : 3 (Coloured) : 4 (Albino)

(b) Dominant epistasis:

In summer squash or Cucurbita pepo, there are three types of fruit colour - yellow, green and white. White colour is dominant over other colours, while yellow is dominant over green. Gene for white colour (W) masks the effects of yellow colour gene (Y). So yellow colour is formed only when the dominant epistatic gene is represented by its recessive allele (w). When the hypostatic gene is also recessive (y), the colour of the fruit is green.

White Fruit - WY , Wy
Yellow Fruit - wY
Green Fruit – wwyy

A cross between a pure breeding white summer squash, (WWYY) with a pure breeding green summer squash, (wwyy) yields white fruits in the F_1 generation. Upon selfing of F_1 the F_2 generation comes to have

12 white fruit : 3 yellow fruit : 1 green fruit.

Parents WWYY X wwyy
White Green
P gametes WY wy
F1 Generation Hybrid WwYy --White
F1 Gametes

Genetic Expression

Female / Male	WY	Wy	wY	wy
WY	WY WY 1 white	Wy WY2 white	wY WY 3 white	wy WY 4 white
Wy	WY Wy 5 white	Wy Wy 6 white	wY Wy 7 white	wy Wy 8 white
wY	WY wY9 white	Wy wY 10 white	wY wY 11 Yellow	wy wY 12 Yellow
wy	WY Wy 13 white	Wy Wy 14 white	wY wy 15 Yellow	wy wy 16 green

F2 generation

WY-White- 1,2,3,4,5,7,9,10,13=9
Wy-White- 6,8,14=3
wY-yellow- 11,12,15=3
wy-Green-16=1

12 white : 3Yellow :1 green

FRUIT COLOUR SQUASH : 12 : 3 : 1

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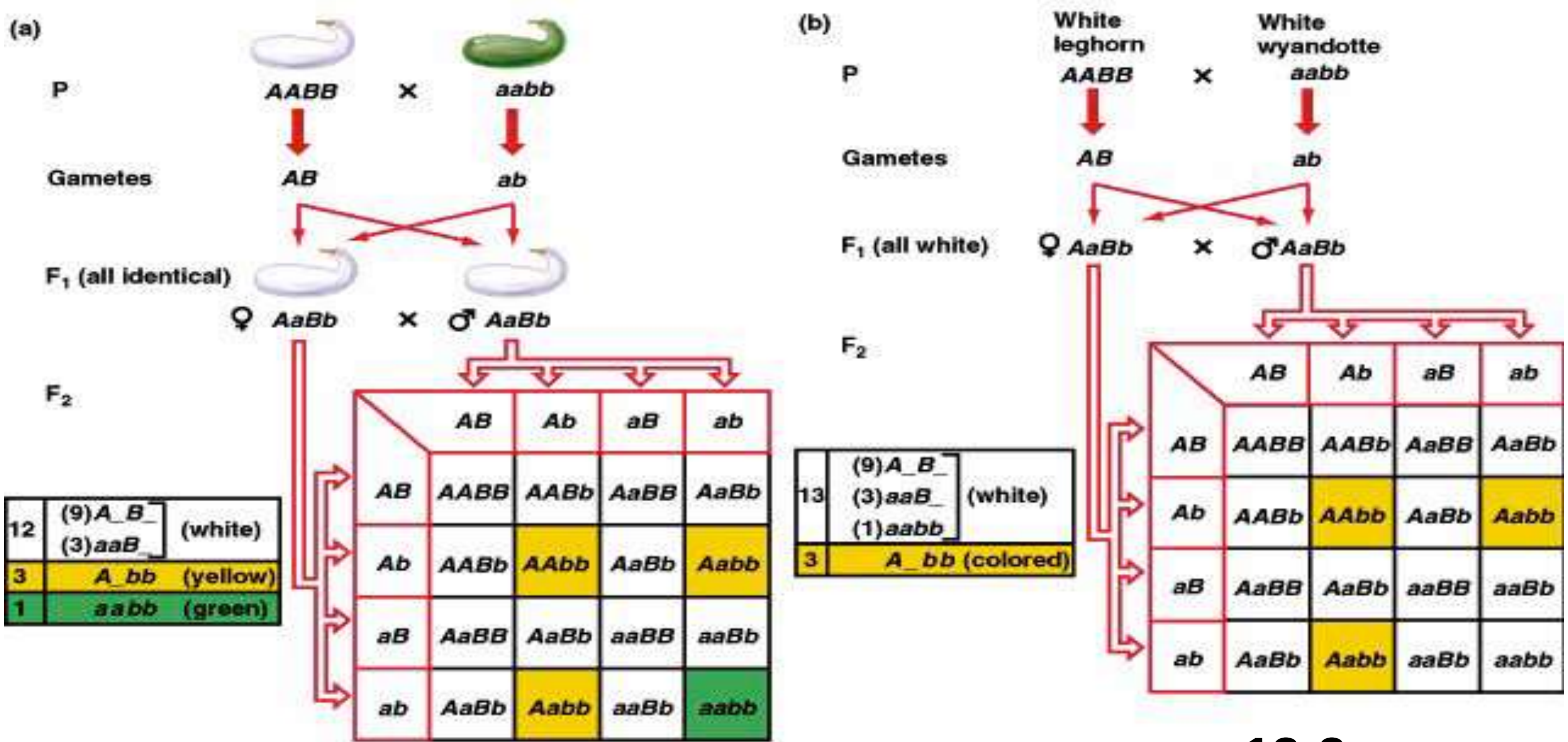
Dominant epistasis



12:3:1

13:3

F1- AaBb X AaBb

9 A B –white 3Aa-bb –Yellow 3 aa-B- White 1 aabb –Green

A causes Yellow but in presence of B can not express ,produce white

COMPLEMENTARY GENES

Two genes are responsible for a particular phenotype. Production of one phenotype requires dominant alleles of both the genes controlling the character.

The complementary genes are two genes present on separate gene loci that interact together to produce dominant phenotypic character, neither of them if present alone, can expresses itself. It means that these genes are complementary to each other

Example is flower colour of Lathyrus odoratus(Keshari/pea grass) .The colour of flower is either purple or white. Purple colour is produced only when dominant A is complemented by Dominant Allele B

Bateson and Punnet have demonstrated that in sweet pea (*Lathyrus odoratus*) purple colour of flowers develop as a result of interaction of two dominant genes C and P. In the absence of dominant gene C or P or both, the flowers are white. It is believed that gene C produces an enzyme that catalyzes the formation of necessary raw material for the synthesis of pigment anthocyanin and gene P produces an enzyme which transforms the raw material into the pigment. It means the pigment anthocyanin is the product of two biochemical reactions, the end product of one reaction forms the substrate for the other.

Substrate A $\xrightarrow{\textbf{Product of Gene C}}$ **Substrate B** $\xrightarrow{\textbf{Product of Gene P}}$ **Anthocyani (Purple)**

Therefore, if a plant has ccPP, ccPp, CCpp or Ccpp genotypes, it bears only white flowers. Purple flowers are formed in plants having genotype CCPP or CCPp or CcPP or CcPp. From checker board, it is clear that **9 : 7 ratio** between purple and white is a modification of 9 : 3 : 3 : 1 ratio.

Genetic Expression

Parents : AAbb X aaBB
White White

P.gametes Ab aB

F1 AaBb -------------------------------- Purple

F1 Gametes Female→

COMPLEMENTAY GENES KESHARI

Male ↓

	AB	Ab	aB	ab
AB	AB AB 1	AB Ab 2	AB aB 3	AB ab 4
Ab	Ab AB 5	Ab Ab 6	Ab aB 7	Ab Ab 8
aB	aB AB 9	aB Ab 10	aB aB 11	aB ab 12
ab	ab AB 13	ab Ab 14	ab aB 15	ab ab 16

F2 Generation

AB- Purple-1,2,3,4.5.7.9,10,13= 9

Where both (A) and (B) are present flowers are coloured

(when A is complemented by B then only flower is coloured)

Where either (A) or (B) is present colour is white

Ab- White- 6,8,14 = 3

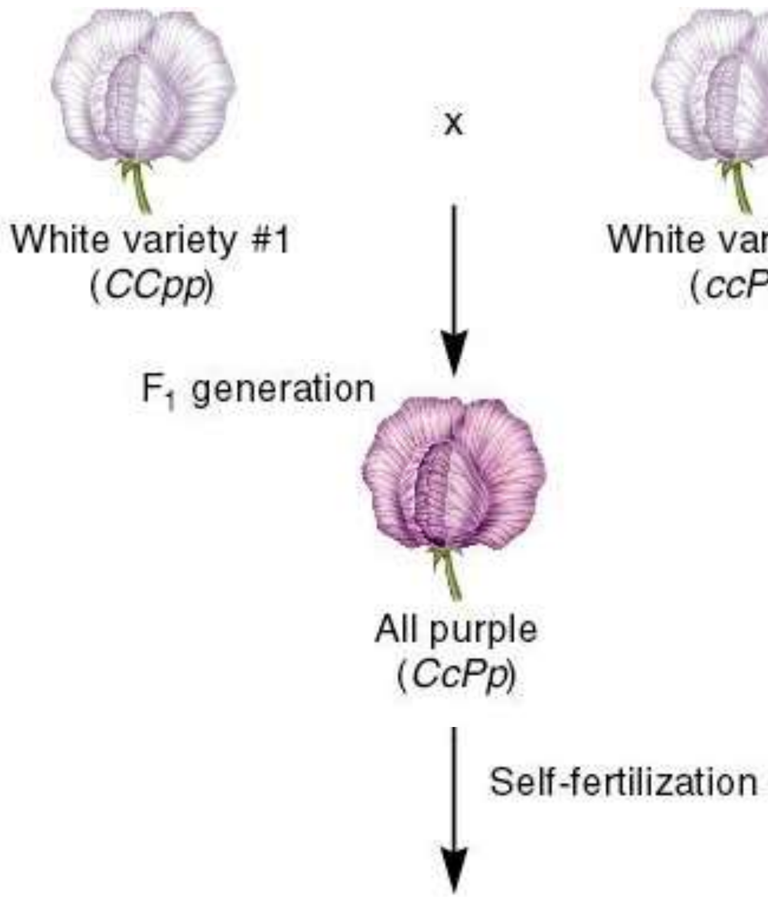
aB- White – 11,12,15 = 3

ab- White -16 = 1

Total white- 3+3+1=7

So the ratio becomes 9:7
(Purple : White)

A Cross Producing a 9:7 ratio

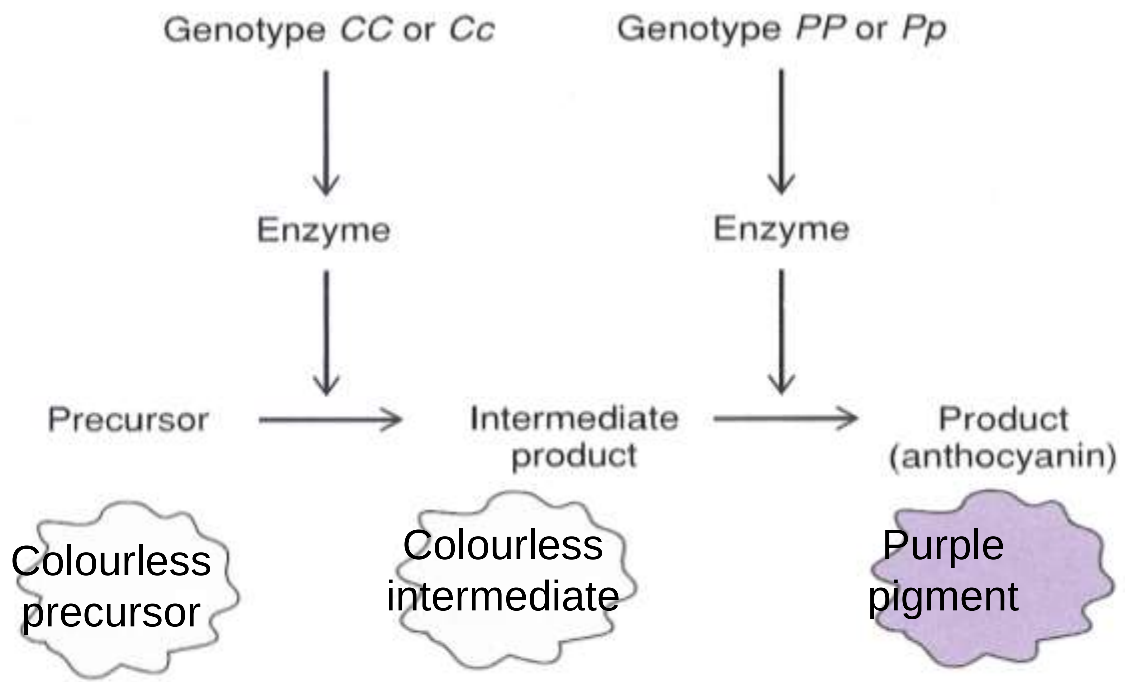


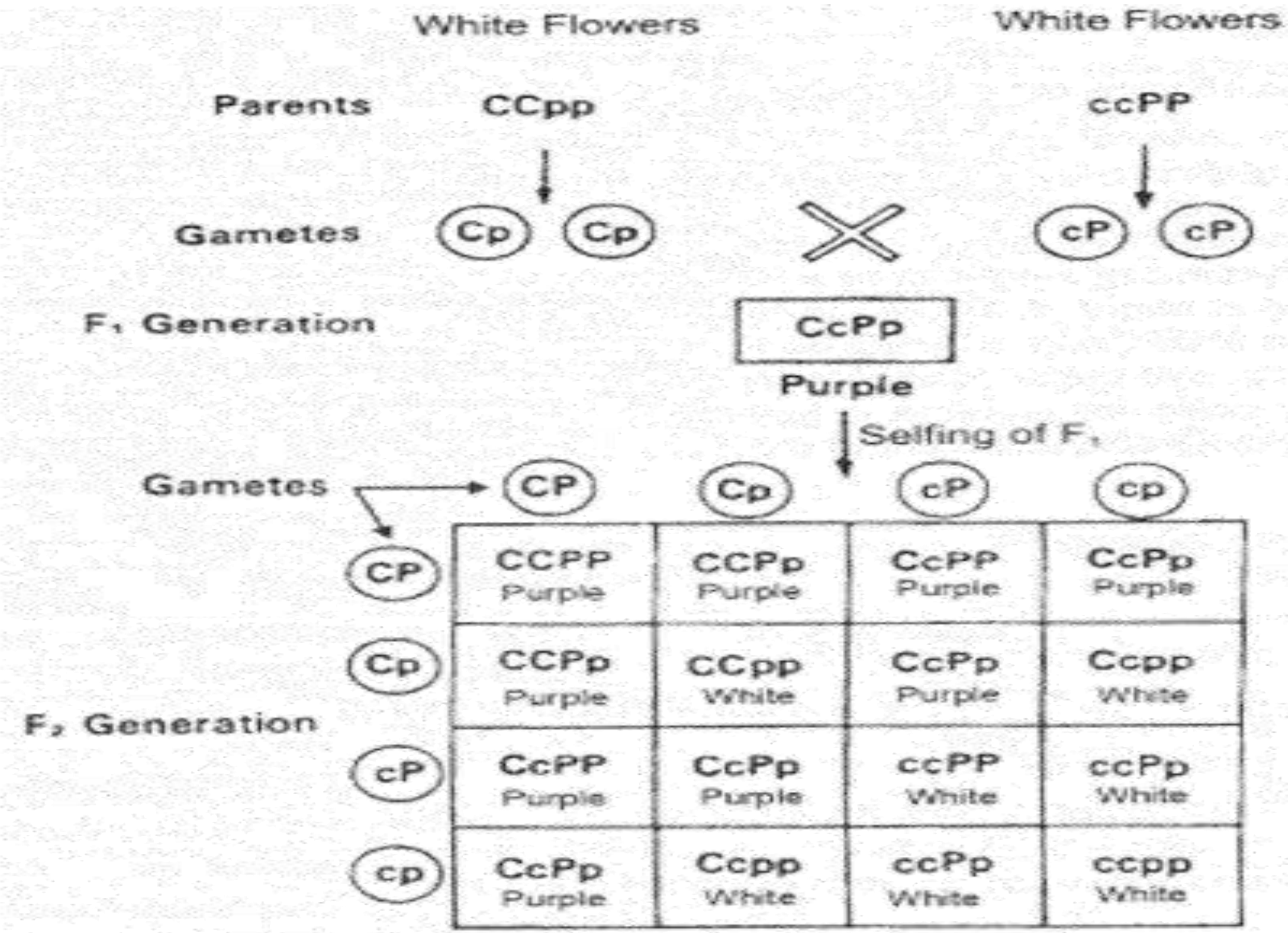
	CP	*Cp*	*cP*	*cp*
CP	*CCPP* Purple	*CCPp* Purple	*CcPP* Purple	*CcPp* Purple
Cp	*CCPp* Purple	*CCpp* White	*CcPp* Purple	*Ccpp* White
cP	*CcPP* Purple	*CcPp* Purple	*ccPP* White	*ccPp* White
cp	*CcPp* Purple	*Ccpp* White	*ccPp* White	*ccpp* White

$$\underbrace{9\ C\_P\_}_{\text{purple}} : \underbrace{3\ C\_pp : 3\ ccP\_ : 1\ ccpp}_{\text{white}}$$

Complementary gene action - interactions arise because the two genes encode proteins that participate in sequence in a biochemical pathway

Enzyme C and enzyme P cooperate to make a product, therefore they complement one another





F_2 phenotypic ratio - 9 (Purple) : 7 (White)

Results of an experiment showing inheritance of flower colour in Lathyrus odoratus controlled by complementary genes

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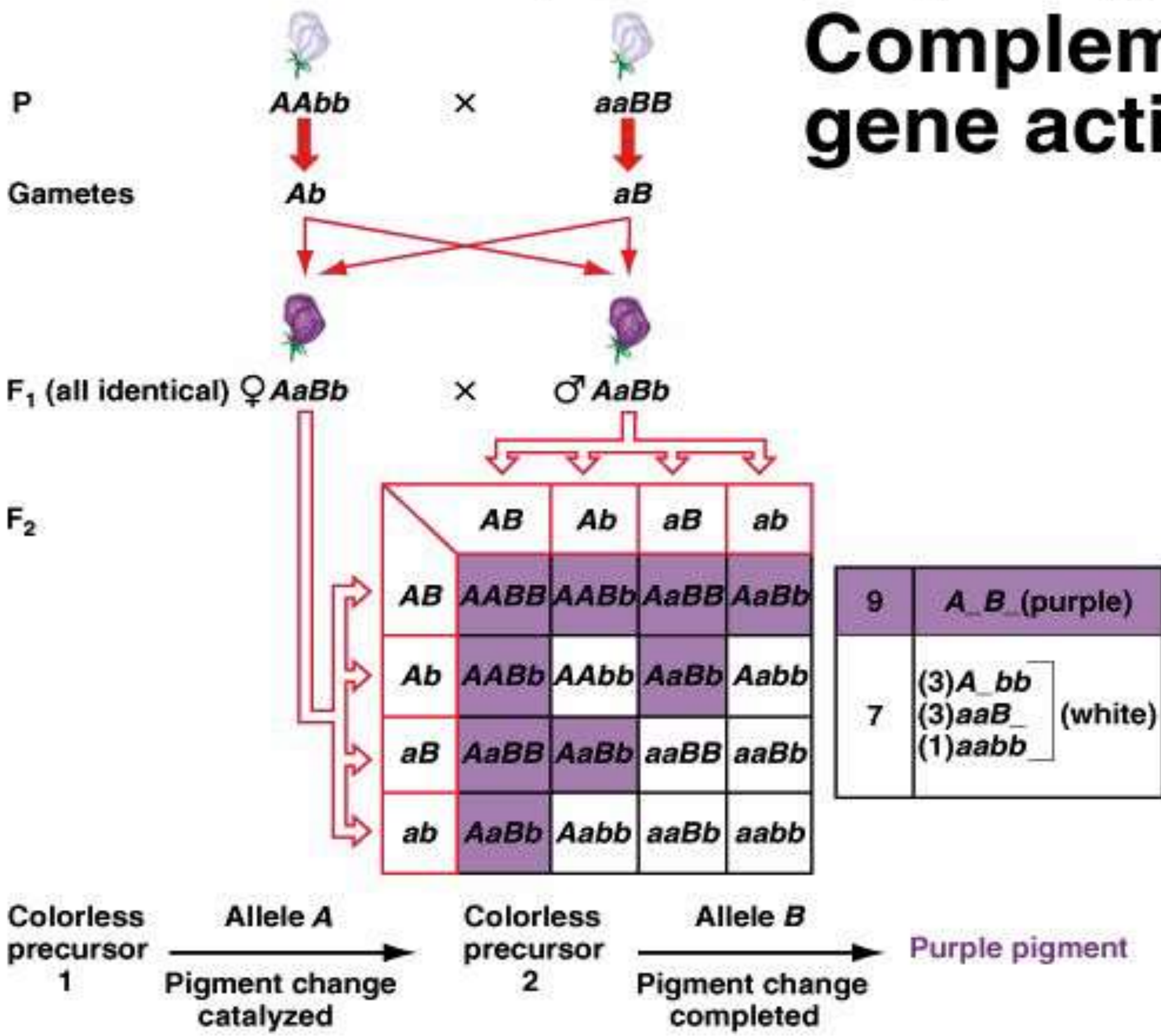
Complementary gene action



	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

9	A_B_ (purple)
7	(3)A_bb (3)aaB_ (1)aabb (white)

Duplicate genes

If the dominant alleles of two gene loci produce the same phenotype, whether inherit together or separately, the 9 : 3 : 3 : 1 ratio is modified into a 15 : 1 ratio.

The capsules of shepherd's purse (Capsella) occur in two different shapes, i.e., triangular and top-shaped. When a plant with triangular capsule is crossed with one having top-shaped capsule, in F_1 only triangular character appears. The F_1 offspring by self crossing produced the F_2 generation with the triangular and top-shaped capsules in the ratio of 15 : 1.

Two independently segregating dominant genes (A and B) have been found to influence the shape of capsule in the same way. All genotypes having dominant alleles of both or either of these genes (A and B) would produce plants with triangular-shaped capsules.

Only those with the genotype aabb would produce plants with top - shaped capsules.

DUPLICATE GENES

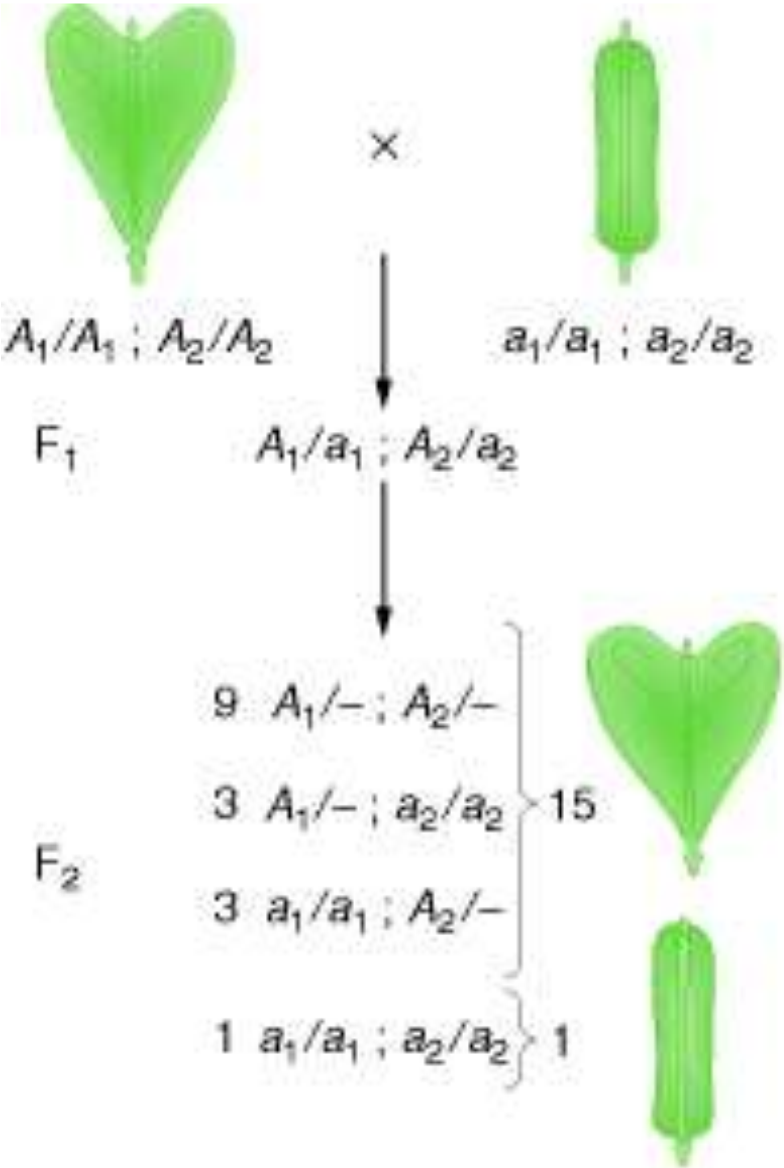
Same effect is given by either of two genes (A) or (B)
Example is Capsella bursa -pastoris (Shepherd's Purse) Fruit shape of two types
a) Triangular (Heart shape) capsule
b) Top shaped (Narrow) capsule

Genetic Expression
Parents AABB X aabb
Triangular Top shaped
P gametes AB ab
F1 (Hybrid) AaBb ------------- triangular

F1 gametes	AB	Ab	aB	ab
AB	AB AB 1	AB Ab 2	AB aB 3	AB ab 4
Ab	Ab AB 5	Ab Ab 6	Ab aB 7	Ab Ab 8
aB	aB AB 9	aB Ab 10	aB aB 11	aB ab 12
ab	ab AB 13	ab Ab 14	ab aB 15	ab ab 16

AB- 1,2,3,4,5, 7,9,10,13=9 (Triangular)
Ab-6,8,14=3(Triangular)
aB-11,12,15 =3 (Tringular)
ab-16 =1 (top shaped) So the ratio is 15:1
This is example of gene interaction,two genes involved in same pathway.It is based on the idea that some genes may be present more than once in the genome

F2 generation
15 (Triangular): 1 (Top)



A_ or B_ = heart shape

aa and bb = narrow shape

Fruit shape in Shepherd's purse

Duplicate Dominant Epistasis

In a cross between two lines differing in fruit shape (Heart shape vs narrow) F1 generation shows all heart shaped like intragenic dominance but F2 generation shows a ratio of 15:1 and not 3:1 as that of monohybrid cross. It means that trait fruit shape is controlled by two genes (A and B) and their Alleles a and b. 15 :1 ratio is therefore modification of dihybrid ratio 9:3:3:1 in which 9,3 and 3 are grouped.The triangular shape results by the presence of at least one dominant allele of either gene. The two gene appear to be identical in function and is in contrast with complemenatary genes or 9:7 ratio where both dominant alleles are required for a phenotype and they complement each other.

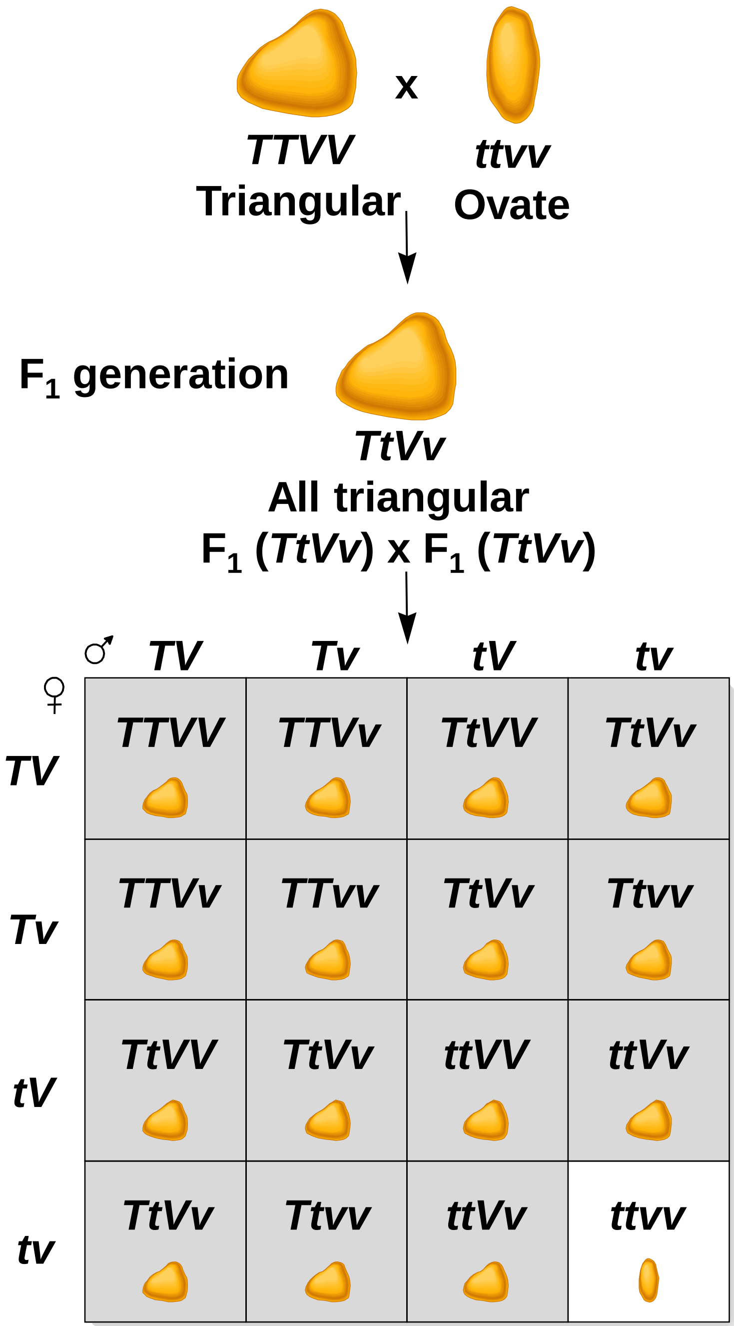
Duplicate genes provide alternative genetic determination of a specific phenotype

Duplicate Gene Action Epistasis

15:1 ratio results

Shepherd's Purse (Capsella)

Fruit Shape Triangular / Top (Ovate) shape



Parents Triangular Top-shaped

AABB aabb

Gametes (AB) × (ab)

F_1 (AaBb)

Triangular

Selfing of F_1

F_2 Generation

Gametes	AB	Ab	aB	ab
AB	AA BB Triangular	AA Bb Triangular	AA Bb Triangular	Aa Bb Triangular
Ab	AA Bb Triangular	AA bb Triangular	AA bb Triangular	Aa bb Triangular
aB	Aa BB Triangular	Aa Bb Triangular	Aa Bb Triangular	aa Bb Triangular
ab	Aa Bb Triangular	Aa bb Triangular	Aa bb Triangular	aa bb Top shaped

F_2 phenotypic ratio : 15 (triangular) : 1 (Top shaped)

2^{nd} Example : Petal colour in snapdragon
Redundancy : Duplicate Genes

P AABB aabb

AB ab

AaBb

F1 AaBb X AaBb

F2 15/16 Red : 1/16 white

Whenever a dominant gene is present, the trait is expressed.

One allele is sufficient to produce the pigment.

Polymeric gene action 9:6:1

Two completely dominant genes controlling a character produce same phenotype, when their dominant alleles are alone, But when dominant alleles are together , the phenotypic effect is enhanced and become cumulative or additive effect

Example -1 Awn length on Barley fruit

AABB x aabb

A /B- Median Awn   A & B – long Awn   ab- Awnless

Example- 2 Fruit shape Squash (Disc/Circular/Long) 9:6:1

AaBb X AaBb

9 A B – Disc   3 A-bb – Circular

3 aa-B- Circular   1 aabb – Long

Example awn length on Barley fruit AB- Median Awn

A & B – long Awn ab- Awnless

Genetic Expression

Parents AABB(Long awn) X aabb(Awnless)

P gametes AB ab

F1 AaBb Long awn

F1 gametes	AB	Ab	aB	ab
AB	AB AB 1	AB Ab 2	AB aB 3	AB ab 4
Ab	Ab AB 5	Ab Ab 6	Ab aB 7	Ab Ab 8
aB	aB AB 9	aB Ab 10	aB aB 11	aB ab 12
ab	ab AB 13	ab Ab 14	ab aB 15	ab ab 16

AB – Long Awn -1,2,3,4,5,7,9,10,13=9
Ab- Medium Awn -6,8,14=3
aB- medium Awn-11,12,15=3
ab-Awnless-16=1

F2 Generation : Phenotypic ratio

9(Long) : 6(Medium) :1(awnless)

INHIBITORY GENE ACTION

Inhibitory gene action Example Maize Aleurone colour 13:3

One dominant gene produces concerned phenotype and its recessive allele produces contrasting phenotype. The second gene (dominant) has no effect on concerned phenotype but stops expression of dominant allele of first gene, so when both dominant alleles are present ,phenotype as that of recessive homozygote is produced

. Genetic Expression
Parents RRII(White aleurone) X rrii (White aleurone)
P gametes RI ri
F1 hybrid ----------------RrIi -----------------------White
F1 gametes

Genetic Expression

Parents RRII(White aleurone) X rrii (White aleurone)

P gametes RI ri

F1 hybrid ----------------RrIi -----------------------White

F1 gametes

	RI	Ri	rI	ri
RI	RI RI	Ri RI	rI RI	ri RI
Ri	RI Ri	Ri Ri Red	rI Ri	ri Ri Red
rI	RI rI	Ri rI	rI rI	rirI
ri	RI ri	Ri ri Red	rI ri	ri ri

RI-White-1,2,3,4,5,7.9.10,13=9

Ri- Red- 6,8,14=3

rI- white -11,12,15=3

ri-white-16=1

So phenotypic Ratio becomes

13 (White) : 3 (Red)

Inhibitory gene action Example Maize Aleurone colour 13:3

Second Example 13 :3

Inhibitory gene (one gene inhibits expression of the other) 13: 3

Example –Feather colour in Fowl (White/Coloured)

Epistasis

AaBb X AaBb

9 A B –white

3 A-bb –white

3 aa-B- coloured

1 aabb –white

B is responsible for colour but in presence of A cannot express

Masking gene action (12:3:1)

Dominant alleles of two genes affecting a character produce distinct phenotypes when they are alone,but when dominant alleles of both genes are present together , expression of dominant allele of one gene masks the expression of other and when both genes are present in recessive state , a different phenotype is produced

Example Barley seed colour –Black/Yellow/White

Parents BByy (Black) X bbYY (Yellow)
P gametes By bY
F1 (Hybrid) BbYy Black
F1 gametes

Parents BByy (Black) X bbYY (Yellow)
P gametes By bY
F1 (Hybrid) BbYy Black
F1 gametes

	BY	By	bY	by
BY	BY BY	By BY	bY BY	by BY
By	By BY	By By	bY By	by By
bY	bY BY	bY By	bY bY	by bY
by	by BY	by By	by bY	by by

BY – Black - 1,2,3,4,5,7,9,10,13=9

By –Black- 6,8,14=3

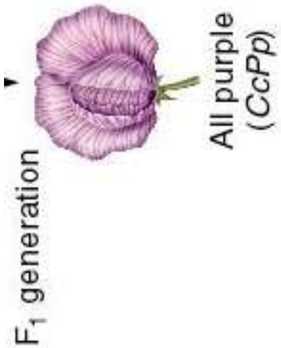
bY- Yellow-11,12,15=3

by-white-16=1

F2 Generation ---- 12 (Black) : 3 (Yellow) : 1 (White)

When both B and Y are present both express but Black colour is so intensive that yellow colour produced by Y is not detected

B gives Black colour,Y gives Yellow colour and b and y donot produce colour


F$_1$ generation
All purple
($CcPp$)


THANK YOU